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FCC Econometric Analysis of Potential Discrimination Utilization Ratios for Minority- and Women-Owned Companies in FCC Wireless Spectrum Auctions

December 5, 2000

A Study Prepared by
Ernst & Young LLP
for the
Federal Communications Commission

**FCC Econometric Analysis of Potential Discrimination
Utilization Ratios for Minority- and Women-Owned Companies in FCC
Wireless Spectrum Auctions**

1. Introduction and Executive Summary

Utilization ratios are a means of measuring the participation and success of minority- and women-owned businesses in the Federal Communications Commission (FCC) wireless spectrum auctions. In this context, a utilization ratio indicates the share of, say, minority-owned companies that were successful in obtaining a spectrum license through an auction out of all minority-owned companies that participated in the auction. Comparison of these ratios across groups highlights any potential systematic differences in auction outcomes.

There are different ways of calculating utilization ratios, depending on how success and participation are measured. Perhaps the simplest way of calculating utilization ratios for spectrum auctions is to determine the number of auction participants who won at least one license as a percentage of all participants. While conceptually straight-forward, this measure does not capture, for example, potential differences in the rates at which participants qualified to bid¹, or any differences in the value of the licenses won². In order to develop a more thorough understanding of auction outcomes for minority- and women-owned companies, this report presents a number of different utilization ratio measures:

- *General Utilization Ratio.* Percentage of auction winners (those who won at least one license) among all auction applicants.
- *Qualifying Ratio.* Percentage of applicants who qualify to bid among all auction applicants.
- *Success Ratio.* Percentage of auction winners (those who won at least one license) among all qualified auction applicants.
- *Economic Value Ratio.*³ An alternative way of assessing the extent to which minority- and women-owned companies are able to secure wireless spectrum licenses is to evaluate their share of the total economic value of the licenses auctioned. The Economic Value Ratio is defined as the economic value of licenses secured by applicants in a particular group, for example minority-owned companies, expressed as a percentage of the total economic value of licenses auctioned.
- *Average Revenue per Winner.* If the number of winners in a group is small, then the Economic Value Ratio for that group would naturally be low, even if there were no systematic differences in the values of licenses obtained across groups. Average revenue per winner provides another measure of auction outcomes for different groups, while controlling for the number of winners.

¹ Throughout this report, an auction applicant is defined as a company (or an individual) who submitted Form 175 ("Short Form") indicating an interest to participate in an auction. In order to bid in an auction, applicants had to qualify by paying an upfront payment. Not all applicants qualified to bid.

² As measured by the FCC's net revenue. Net revenue is the revenue collected from the winning bidder, after deducting bidding credits, if any.

³ For the purposes of this report, "economic value of a license" is defined as the net revenue the FCC received for the license. Net revenue equals the winning bid, minus bidding credits, if any.

- *Return on Payment Ratio.* Another approach to scaling the revenues generated by various groups is to use the upfront payments as a scaling factor. The upfront payments determine bidding eligibility and hence affect auction outcomes. The return on payment ratio is calculated as the percentage of net FCC revenues relative to the percentage of upfront payments. For example, suppose that minority-owned companies generated 15% of net FCC revenues and paid 10% of the upfront payments in a particular auction. Then the Return on Payment Ratio for minority-owned companies is 1.5, indicating that the minority share of revenues is 1.5 times the minority share of upfront payments.

Each of these ratios presents a different view on how minority- and women-owned companies obtain licenses through the spectrum auction process. In general, these ratios can be classified into two categories: measures of auction outcomes, and measures of financial implications of those outcomes.

The general utilization ratio provides an overall view of the auction outcomes, based on the number of applicants and winners. The qualifying and success ratios refine this concept further, by breaking the auction process into two parts: qualifying to bid, and winning after qualifying. Contrasting these two measures will identify whether any differences found in the general utilization ratios are attributable to differences in qualifying or in succeeding after qualifying, thus providing insights into where in the auction process there may be differences across groups of applicants.

The other measures are more financial measures of auction outcomes. Simply counting winners and losers may obscure the fact that some licenses are more valuable than others, and that there may be differences in the value of licenses acquired across groups of applicants. The financial measures of auction outcomes address these issues by examining revenue shares, and scaling them by numbers of applicants or by upfront payments.

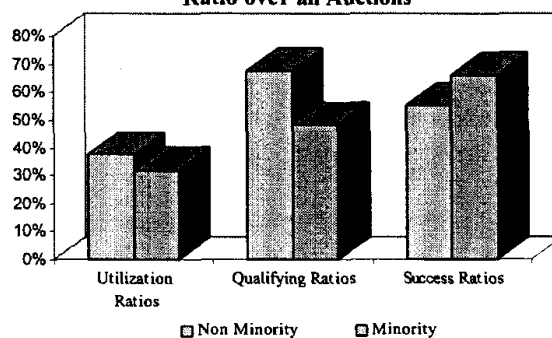
Both types of measures are useful in evaluating the ability of minority- and women-owned companies to acquire spectrum licenses through auctions, as they provide different points of view. Taken together, they will provide a more comprehensive picture of auction outcomes across different groups of auction applicants.

Our main findings, by ratio type, from this analysis are:

Aggregate Utilization Ratios:

- When participation and success is measured by counting the percentages of winners from all auction participants (general utilization ratio), minority and women applicants appear to be somewhat less likely to win at least one license relative to other applicants. These differences are statistically significant.⁴
- Examination of the qualifying ratio indicates that minority and women applicants tend to qualify at lower rates than other applicants and that these differences are statistically significant. On the other hand, analysis of success ratios reveals that among qualified applicants, there are no statistically significant differences between women and other applicants in their likelihood of winning licenses. Success ratios also indicate that on average, qualified minority applicants are more likely to win than qualified non-minority applicants. This difference is statistically significant. These findings would suggest that the difference in general utilization ratios may be largely attributable to the differences in qualifying ratios where minority applicants face a lower likelihood of qualifying. However, once qualified, minorities appear to have higher odds of success in auctions.
- Figure 1 presents the differences in average⁵ general utilization, qualifying, and success ratios between minority and non-minority applicants.

Figure 1
General Utilization Ratio, Qualifying Ratio, and Success
Ratio over all Auctions



* Indicates that differences in the ratios across non minority and minority groups were statistically significant at the 95% level

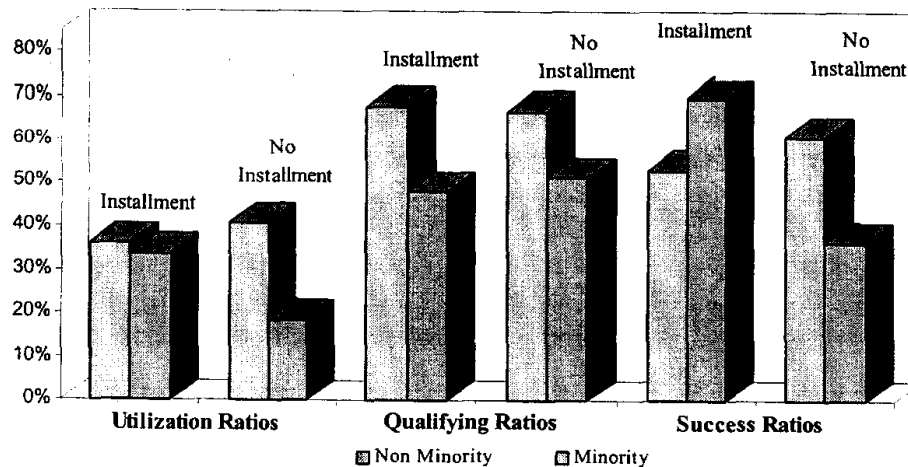
Impact of Installment Plans

- When the various utilization ratios are analyzed separately for auctions with and without installment plans, it appears that installment plans generally increase the rate at which minority and women applicants win licenses. Figure 2 presents the same ratios as Figure 1 but calculated separately for auctions with installment plans and without installment plans. Although the utilization and qualifying ratios are still lower for minorities than for non-minorities for both auctions with and without installment plans, in auctions with installment plans the success ratio is higher for minorities than for non-minorities and the difference is statistically significant.

⁴ See pages 9-10 for a discussion of the concept of statistical significance.

⁵ Calculated across all auctions.

Figure 2
Installment Plan vs. No Installment Plan



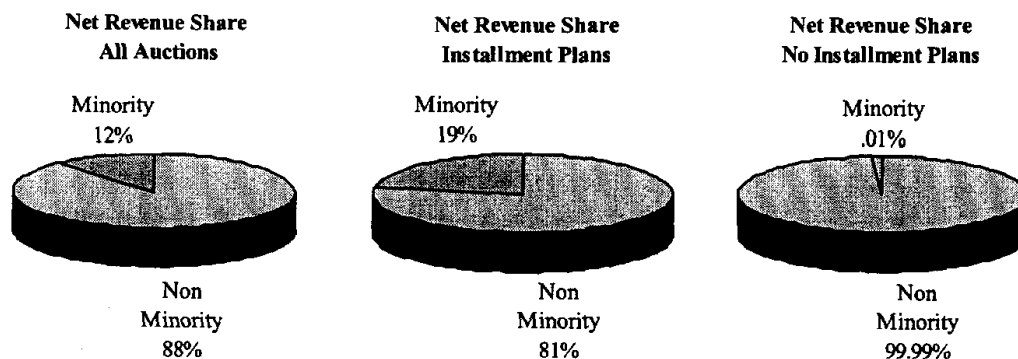
* Indicates that differences in the ratios across non minority and minority groups were statistically significant at the 95% level

- The difference in outcomes for minorities between auctions with and without installment plans may reflect various factors. Installment plans may relax potential capital constraints, or, alternatively, they may lead to inflation of the price of the license and aggressive bidding. Further study is required to definitively evaluate the effects of installment plans.

Economic Value Analysis

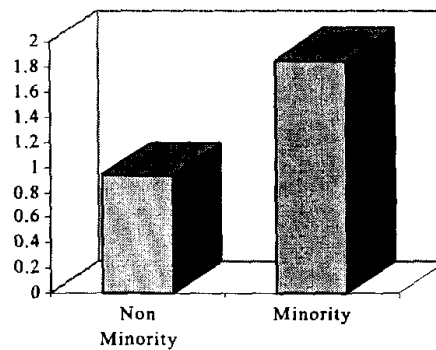
- The analysis of economic value shares (i.e., shares of net FCC revenue generated from the auctions) revealed that in the aggregate, the value of licenses acquired by minority winners is approximately 12% of the total value of licenses. However, in auctions with installment plans, the minority share of total value increases to approximately 19% (see Figure 3). The value shares for women winners exhibit a similar pattern.

Figure 3
Economic Value Shares



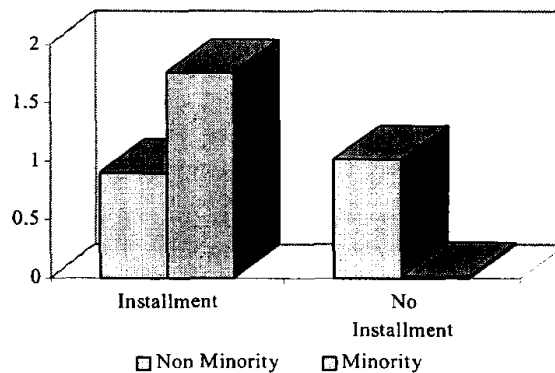
- When the economic value of licenses acquired is examined on a per winner basis (average economic value per winner), there are no statistically significant differences between minority and women applicants, and other applicants at the aggregate level. In other words, while the number of minority and women winners is relatively small, compared to the number of other winners, the value of their licenses won is comparable to that of other winners, on average.
- When economic value of licenses relative to the upfront payments is compared across different applicant groups (return-on-payment ratio), minority and women applicants tend to obtain a larger share of the economic value of the licenses than their share of upfront payments. If upfront payments are taken as a measure of the value and number of licenses applicants are interested in winning, this finding would seem to indicate that minority and women applicants tend to win at least as many and/or as valuable licenses as they are interested in winning. However, upfront payments may be an imperfect indicator of interest, if applicants are unable to make upfront payments in the amounts they desire. Figure 4 illustrates the average return-on-payment ratios for minorities across all auctions.

Figure 4
Return on Payment Ratio for all Auctions



- When return-on-payment ratios are analyzed separately for auctions with and without installment plans (Figure 5), the ratios for minorities are much higher in auctions with installment plans. Ratios for women have a similar pattern.

Figure 5
Return on Payment Ratios for Installment vs.
No Installment Plan Auctions



Other findings

- The analysis by industry groups revealed few statistically significant patterns across industries⁶ in the comparison of utilization ratios between minority and women applicants, and other applicants. In advanced paging/data auctions all three measures of utilization (general utilization, qualifying, and success ratios) are significantly lower for minorities than for non-minorities.
- The differences in utilization ratios between minority and women applicants, and other applicants are typically less pronounced among small companies than among large companies. Among small companies, auction outcomes are generally more comparable across applicant groups than among large companies.
- In the first three auctions, minority and women applicants were eligible for bidding credits. In these auctions, the economic value shares tended to be generally larger for minority and women applicants than in other auctions.

When interpreting the utilization ratio calculations, it is important to keep in mind that they are based on a high-level analysis that does not control for many important applicant characteristics that may affect auction outcomes and may provide explanations for the observed differences across applicant groups. For example, the findings suggest that installment plans increase the likelihood of winning for minority applicants, which may reflect the easing of capital constraints, if any, or inflation in the value of licenses. These results may also be the artifacts of differing auction strategies employed by different participants. For example, large companies may strategically place upfront payments across a wider array of spectrum than their business needs, and focus their interest as the auction proceeds, leading to a lower return-on-payments. We are currently developing further more detailed analysis into the determinants of auction outcomes.

⁶ Advanced paging/data; mobile voice and data; interactive data; wireless cable; multichannel video.

The remaining sections of this report provide a more detailed discussion of our analysis.

2. Data

The FCC provided Ernst & Young LLP (E&Y) with data on 19 auctions⁷ that E&Y used to calculate preliminary utilization ratios.⁸ For each auction applicant, the data include the following information:

- Indicator for Qualifying Applicant
- Name
- Indicator for Small Business
- Indicator for Rural Business
- Indicator for Woman-owned Business
- Indicator for Minority-owned Business
- Number of High Bids
- Total Population in Areas for each winning bid
- Sum of High Bids \$ (Net)
- Sum of High Bids \$ (Gross)
- Upfront Payment
- Bidding Eligibility

The indicators for minority-owned, women-owned, and small businesses are based on self-reported data. It is our understanding that the FCC has not asked applicants to verify their minority- or women-owned status, but when an auction applicant identified itself as a small business, it also had to provide some verification to the FCC of its small business status.^{9 10}

3. Utilization Ratio Calculations

Each of the utilization ratios is calculated separately for each auction, as well as for groups of auctions. Aggregating data across auctions allows us to detect general high-level patterns, if any, that might not emerge in an auction-by-auction view. Two natural groupings of auctions are by rule structure and by industry type. Auction rules have varied considerably, and in particular, some auctions have provided special installment plans for small businesses while others have not. An interesting question is whether these special programs had an impact on participation of minority/women-owned businesses.

⁷ Auctions 1-21, with the exception of auctions 13 and 19, which were never held.

⁸ E&Y has not conducted an independent audit of the data and makes no representations of the accuracy of the data.

⁹ The type of verification has varied over time.

¹⁰ In the very first auctions (Auctions 1 through 3), minority and women owned businesses were granted bidding credits, but subsequently, only small businesses have qualified for bidding credits. Hence, in most auctions applicants have not had a direct reason to identify themselves as minority- or women-owned businesses. On the other hand, bidding credits for small businesses have been in place in many auctions (Auctions 3, 4, 5, 6, 7, 10, 11, 14, 16, 17, 18, 20, 21).

Similarly, the licenses have been sold in a number of distinct industries, and there might be some industry-specific factors influencing the extent of minority/women-owned business participation in auctions. The groups of auctions are¹¹:

- **Auction Rule Structures Group**

Group 1: Installment Plans (auctions # 2,3,5,6,7,10,11)

Group 2: No Installment Plans (auctions # 1,4,8,9,12,14,15,16,17,18,20,21)

- **Industry Groups**

Group 1: Advanced Paging/Data (auctions # 1,3,18)

Group 2: Mobile Voice and Data (auctions # 4,5,7,10,11,12,14,15,20,21)

Group 3: Interactive Data (auction # 2)

Group 4: Wireless Cable (auction # 6,17)

Group 5: Multichannel Video (auction # 8,9)

In another grouping, applicants are grouped on the basis of their self-reported size into small and large companies¹², and utilization ratios are calculated separately for each group. Company size may be one of the determinants of auction outcomes, and hence it is instructive to conduct utilization ratio comparisons for groups of companies that are similarly sized.¹³

In addition to presenting the utilization ratios for the various groups, the report lists aggregate (or average) utilization ratios. These are calculated in two ways: simple averages, and revenue-weighted averages. First, we calculate the aggregate utilization ratios by using the total numbers of auction applicants and winners across all auctions. Second, we calculate average utilization ratios from the per-auction ratios that are weighted by auctions' revenue shares. For example, suppose that Auction 1 generated 10% of revenues from all auctions combined, and that Auction 2 generated 15% of all revenues. Then, in the calculation of the average revenue-weighted utilization ratio for, say, minority applicants, the minority utilization ratio from Auction 1 would receive a weight of 10%, and the ratio from Auction 2 would receive a weight of 15%.¹⁴ Both average utilization ratio measures are reported at the bottom of each table for reference.

For each ratio, E&Y conducted tests to determine whether the differences in the ratios across groups were statistically significant. In these tests, minority applicants are compared to non-minority applicants (i.e., all other applicants who did not identify themselves as minority applicants), and women applicants are compared to all other applicants (who did not identify themselves as women-owned companies). The concept

¹¹ The auction rule structures groups are based on the information provided to us by the FCC. The industry groups are based on our understanding of the information in the bidder packages provided to us by the FCC.

¹² For the purposes of this report, a company is considered large, if it has not identified itself as a small company on the auction application.

¹³ It should be noted, though, that the category 'large' may encompass very wide differences in company size, given the way it has been defined.

¹⁴ Auctions or auction groups without any minority/women applicants are omitted from these averages.

of statistical significance is used to differentiate between systematic patterns and chance occurrences. Even in the absence of any systematic differences auction outcomes between, say, minority and non-minority auction applicants, one would not expect the utilization ratios for the two groups to be exactly the same. The question is then whether a difference in the ratios indicates a systematic pattern. Statistical significance tests are a common approach to determining this. For example, when the statistical significance test indicates a 95% level of confidence, there is a 95% chance that a difference in utilization ratios is due to a systematic pattern and only a 5% chance that there is no true difference. The 95% level is typically used as the threshold level for deeming a result statistically significant, i.e. if the confidence level is at least 95%, the result is considered statistically significant; otherwise it is not.¹⁵ The confidence level of a test is affected by not only the absolute magnitude of the difference in utilization ratios, but also by other factors, such as the number of applicants on which the utilization ratios are calculated. Hence, a small difference may at times be statistically significant, while a large one might not.

Although the full population of auction applicants is used in the calculations presented in the body of this report, tests of statistical significance are a good benchmark for comparison across groups, given the interest in examining utilization ratios in the auction process in general, rather than in a specific auction at a specific point in time. Since the auctions are an on-going process, the populations that participated in each of the auctions can be viewed as draws from a "superpopulation," and statistical testing of hypotheses is appropriate.

A. General Utilization Ratio

The general utilization ratio is an overall measure of the extent to which minority/women-owned businesses participate in auctions. It is calculated as the percentage of winners among all auction applicants. Table 1 shows the general utilization ratios by auction as well as for all auctions as a whole. For all auctions as a whole, there are some differences across general utilization ratios across demographic groups: 37.40% of non-minority applicants and 31.97% of minority applicants win licenses, while the shares are 32.01% for women-owned applicants and 37.35% for other applicants. Both of these differences are statistically significant, indicating that on average, minority- and women-owned firms win licenses at slightly lower rates than other firms. The revenue-weighted average general utilization ratios provide similar information: 28.89% for non-minorities vs. 22.02% for minorities, and 18.81% for women applicants vs. 29.18% for other applicants.

In the auction-by-auction comparison, the percentage of winning minorities is sometimes larger (e.g., auctions 2 and 7) and sometimes smaller (e.g., auctions 6 and 17) than the corresponding percentage for non-minority applicants. Similarly, women applicants sometimes win licenses more frequently than other applicants (e.g., auction 17) and

¹⁵ A Chi-square test was applied when the ratios were based on counts, such as number of auction winners. A t-test was applied when the ratios were based on continuous variables, such as revenue amounts. Appendices A and B describe the calculation of these statistics in detail.

sometimes less frequently (e.g., auction 11). However, the number of minority and women applicants and/or winners is too small in most auctions (13 out of 19) to allow the use of statistical tests, so for most auctions, it is unclear what, if any, underlying patterns these differences represent on a per-auction basis. In the auctions where the number of minority and women applicants and/or winners permits the calculation of valid tests, none of the differences are statistically significant.

When auctions are analyzed by auction groups based on auction rules (Table 2), minorities appear to be just as likely to win licenses in auctions with installment plans, whereas there is a statistically significant difference between minorities and non-minorities in auctions without installment plans, with minorities winning licenses less frequently than non-minorities. In other words, it appears that the presence or absence of installment plans does affect the outcomes for minorities, as measured by the general utilization ratio. On the other hand, installment plans appear to make less of a difference for the outcomes for women auction applicants. Women are less likely than other applicants to win licenses in auctions with installment plans. This difference is statistically significant.

The analysis by industry group (Table 3) shows that minority applicants win licenses at significantly lower rates than non-minority applicants in advanced paging/data auctions but not in other industry groups. Women applicants also win licenses less frequently than other applicants in advanced paging/data auctions, as well as in mobile voice and data auctions.

When auction applicants are grouped by size (Table 4), there are no systematic differences in outcomes between minority/non-minority and women/other applicants among small companies. In contrast, both minority- and women-owned applicants have significantly lower general utilization ratios among large companies.

B. Qualifying Ratio

In order to bid in the auctions, applicants must qualify by submitting Form 175 ("short form") and an upfront payment. The upfront payment depends on desired bidding eligibility. Bidding eligibility is measured in bidding units, and each license to be auctioned requires a certain number of bidding units. For example, an applicant who provides an upfront payment that qualifies him for 100 bidding units is able to bid on any combination of licenses such that the total bidding eligibility requirement does not exceed the 100 units. Failure to make the upfront payment or to complete the "short form" will result in disqualification. A potential reason explaining the differences in general utilization ratio between minority and non-minority applicants and between women and other applicants, described above, is differences in rates at which minorities and women qualify to bid, relative to other applicants. To examine the impact of the qualifying process, we study the qualifying ratio separately from the general utilization ratio.

The qualifying ratio is defined as the percentage of minority/non-minority and women/other applicants that qualify to bid. Table 5 shows qualifying ratios by auction as well as for all auctions as a whole. The average qualifying ratios across all auctions indicate significant differences between the outcomes of minority and women applicants, relative to other applicants. The average qualifying ratio for minority applicants is 48.3%, while it is 67.5% for non-minority applicants. Similarly, the average qualifying ratio for women applicants is 51.9%, and 66.6% for other applicants. Both of these differences are statistically significant, indicating that there are systematic differences in qualifying rates between minorities and women applicants as compared to other applicants.

In eight of the 19 auctions, the number of minority/women applicants and/or qualified applicants is too small to permit the calculation of statistical tests regarding the significance of the difference in qualifying ratios. In other auctions, the tests indicate some statistically significant differences in qualifying ratios. Minorities qualify at significantly lower rates than non-minority applicants in auctions 3, 5, 6, 10, and 11. Women qualify at significantly lower rates than other applicants in auctions 5, 10, and 11.

Table 6 presents the qualifying ratios when auctions are grouped by auction rules, i.e., whether auctions had installment plans or not. Minorities qualify at significantly lower rates regardless of whether auctions had installment plans or not. Women qualify at significantly lower rates in auctions with installment plans, but no such difference appears in auctions without installment plans.

In the analysis by industry group, minorities again qualify at significantly lower rates in three of the five industry groups (advanced paging/data, mobile voice and data, and interactive data). The number of minorities is too small to permit statistical tests in wireless cable auctions, and there are no statistically significant differences in qualifying ratios in the fifth industry group, multichannel video. For women applicants, the only industry group with statistically significant differences in qualifying ratios is mobile voice and data. As for minority applicants, the number of women applicants is too small in wireless cable auctions to permit the calculation of statistical tests.

Company size appears to make no difference in qualifying ratios. When large minority/women companies are compared to other large companies, they qualify at statistically lower rates. The same holds in the comparison of small minority/women companies to other small companies.

These findings from the study of the qualifying ratio indicate that at least some of the differences evident in general utilization ratios between minority/women applicants and other applicants can be attributed to differences in qualifying ratios. In general, minority and women applicants tend to qualify at significantly lower rates than other applicants. A possible reason for the lower qualifying rates may be differential access to capital, which may hinder the ability of minorities and women to make the necessary upfront payments.

However, a more in-depth analysis is required to arrive at authoritative conclusions about the reasons behind this apparent disparity.

The next step in the analysis is to evaluate success rates for qualified applicants to determine whether after qualifying there are differences in auction outcomes between minority and women applicants relative to other applicants.

C. Success Ratio

The success ratio is a measure of qualified applicants who win bids, and is calculated as the percentage of winners among qualified applicants.

Table 9 shows the success ratios by auction as well as the average success ratios. After having qualified to bid, minority applicants in fact win licenses at a higher rate than non-minority applicants (66.1% vs. 55.4%), and this difference is statistically significant. Qualified women applicants also win licenses at a higher rate than other applicants (61.7% vs. 56.1%), although this difference is not statistically significant. Again, in 13 of the 19 auctions, the number of minority and women qualified applicants and winners is too small to permit the calculation of statistical tests. In auctions where testing is possible, however, minorities often win at significantly higher rates (auctions 2, 5, and 11). No such systematic pattern appears in the comparison of women applicants and other applicants on a per auction basis.

When success ratios are examined by auction group, minority and women applicants are more likely to win than other applicants in auctions with installment plans. However, in auctions without installment plans minorities win less frequently than non-minorities and the difference is statistically significant. Women applicants also win less frequently but the difference is not statistically significant. These results mirror those from the analysis of general utilization ratio: again, installment plans appear to enhance the ability of minorities in particular to secure wireless spectrum licenses, while the difference is less marked for women applicants.

Analysis of auctions by industry groups reveals some differences across industries. While minority applicants are statistically more likely to win in mobile voice and data auctions than non-minority applicants, they are less likely to win other industry groups (with the exception of wireless cable, for which the low number of minority qualified applicants precludes the use of statistical tests). For women applicants, the only significant difference emerges in mobile voice and data auctions, in which they are less likely to win than other applicants.

When applicants are grouped by size, there are no differences in success ratios among large companies, either between minority and non-minority applicants or between women and other applicants. However, among small companies, minority applicants win licenses more frequently than non-minorities, and the difference is statistically significant.

In sum, the success ratios indicate that among qualified applicants, minorities and women tend to win licenses just as frequently as other applicants, if not more frequently. This is in marked contrast to the findings from the analysis of qualifying ratios. Those findings showed that minority applicants in particular tend to qualify less frequently than other applicants. On the basis of these results, the lower general utilization ratios for minority and women applicants appear to be related to hurdles in qualifying to bid, but that among those who qualified, the ability of minority and women applicants to secure licenses is comparable to that of other applicants.

D. Economic Value Ratio

The preceding measures of utilization (general utilization ratio, qualifying ratio, and success ratio) have measured utilization as qualifying to bid for or winning at least one license, relative to the number of applicants. These calculations omit any considerations of the economic value of the licenses obtained.¹⁶

An alternative measure of the extent to which minority/women-owned businesses win FCC licenses is their share of the total economic value of licenses.

Table 13 presents the Economic Value Ratios by auction as well as for all auctions as a whole. For all auctions as a whole, the value of the licenses won by minority applicants was 11.9% of the total value of licenses. For women applicants, the share was 7.9%. In other words, minority (women) applicants secured roughly a tenth of the licenses, when measured by the economic value of the licenses.¹⁷ In the auction-by-auction analysis, the value shares for minority applicants have ranged from a low of 0.0% to a high of 31.6%. The range for women applicants is from 0.0% to 45.2%.

Economic value ratios by auction group are provided in Table 14. In auctions with installment plans, the economic value ratios for both minority and women applicants are higher than on average (19.4% and 12.7%, respectively). Consistent with the evidence from the general utilization ratios and success ratios, these figures indicate that in auctions with installment plans, minority and women applicants tend to acquire larger shares of the spectrum for sale, as measured by the economic value of the spectrum.

The economic value shares by industry group are shown in Table 15. In terms of economic value, minority and women applicants obtain their largest shares of the total value of spectrum auctioned in multichannel video auctions.

In table 16, economic value shares are calculated by company size. Among small firms, minority and women applicants obtain higher value shares than on average (22.1% and

¹⁶ Recall that for the purposes of this report, economic value of a license is defined as the winning bid for that license, minus any bidding credits, i.e., the FCC's net revenue for the license.

¹⁷ No statistical tests of significance are reported for these shares. If the minority share of economic value is X% then the non-minority share is by definition (100-X)%, and testing for statistical significance in the shares is not meaningful.

14.6%, respectively). In contrast, their shares are very low among large firms (less than 1%).

The findings from the analysis of economic value shares indicates that in general, minority and women applicants acquire approximately a tenth of the licenses, as measured by their economic value. However, in auctions with installment plans and among small firms, their shares of economic value are larger.

E. Economic Value Per Winner

The economic value ratio calculations show that the bulk of the revenues collected from auctions come from non-minority owned companies, or companies not owned by women. However, this reflects at least partially the fact that the number of minority and women winners is smaller than the number of other winners. In order to evaluate the economic value of licenses acquired by minority and women applicants while controlling for the number of winners, we calculated the average economic value per winner.

Table 17 displays the results on a by-auction basis, and also gives the averages across all auctions. On a per winner basis, the differences in economic value of licenses obtained between minority and women applicants on one hand, and other applicants on the other, appear to be less distinct than in the preceding analysis of overall value shares. The average value per winner for minority applicants is \$22.5 million, while it is \$32.0 million for non-minority applicants. When comparing women applicants to other applicants, the average values are \$15.4 million for women and \$33.2 million for others. Neither of these differences is statistically significant. In the analysis by auction, the average value of a license per winner is significantly lower for minorities in two auctions (Auctions 6 and 11). In 10 out of the 19 auctions, there are not enough minority winners to perform a valid test of statistical significance for the average value of licenses won. The findings for women applicants are quite similar. In Auctions 6 and 11, there are statistically significant differences between women and other winners in the average economic value of licenses won, with women having lower values. In 9 of the 19 auctions, there are not enough women winners for the calculation of statistical tests.

When auctions are grouped by auction rules (Table 18), differences in the average values of licenses per winner are not statistically significant in auctions with installment plans, but they are in auctions without installment plans. This finding echoes those from the previous calculations in which minority and women applicants had higher general utilization and success ratios, and higher economic value shares in auctions with installment plans.

In the analysis of average economic value per winner by industry group (Table 19), the only significant difference is found in the comparison between minority and non-minority winners in interactive data auctions. No significant differences are found in other industry groups, or in the comparison between women and other winners. However, there

are no minority or women winners in wireless cable auctions so the tests cannot be calculated for this industry group.

Table 20 presents the average economic values per winner by company size. Again, the differences are significant among large companies (i.e., large minority- and women-owned companies pay on average significantly less for their licenses than other large companies), but not among small companies. In fact, for minority small companies, the average economic value per winner is higher than for non-minority small companies.

Taken together, the findings from the analysis of average economic values per winner suggest that in general, there appear to be no systematic differences in the average values between minority and women winners, and other companies. While in some auctions the differences are significant, as they are also among large companies, this is offset by the fact that in other auctions and among small companies, the differences are small enough to be statistically insignificant.

F. Return-on-Payment Ratio

The final utilization ratio analyzed in this report is the return-on-payment ratio. The idea behind this ratio is to scale the economic value of licenses won by the upfront payments. Upfront payments determine the number of licenses the applicant is able to bid on, and are indicative of the number and value of licenses the applicant is interested in acquiring.¹⁸ Therefore we would expect applicants who made larger upfront payments to win more licenses and/or more valuable licenses. Differences in the value of licenses won might then be related to differences in upfront payments, and it is interesting to examine to what extent the value of licenses won, relative to upfront payments, differs across groups of applicants.

The return-on-payment ratio is calculated as the percentage of net revenues from minority/women winners relative to the percentage of upfront payments from minority/women applicants. For example, if minority applicants generated 15% of the total FCC net revenue, and paid 10% of the total upfront payments, then this ratio would be $15\%/10\%=1.5$. The calculations of this ratio are limited to 11 of the 19 auctions because we did not have data on upfront payments for all auctions.

Table 21 presents the overall return-on-payment ratios as well as the ratios by auction. Overall, the value share of licenses won by minority applicants is nearly twice as large as the minority share of upfront payments, as indicated by the return-on-payment ratio of 1.86. For non-minority applicants this ratio is close to 1. Similarly, for women applicants the ratio exceeds 2, whereas for other applicants it is nearly 1. In other words, minority and women winners tend to generate relatively more revenue than their share of upfront payments. If upfront payments are taken as a measure of the number and/or value of licenses applicants are interested in winning, this finding would seem to indicate that

¹⁸ Other factors, such as ability to raise capital for upfront payments, may also play a role in the amount of the upfront payment.

qualified minority and women applicants win at least as many and/or as valuable licenses as they are interested in winning. Of course, if minority and women applicants are not able to make as large upfront payments as they would like, upfront payments are an imperfect indicator of the extent of their interest in licenses. Nevertheless, throughout this analysis of utilization ratios it is important to keep in mind that differences in the number and value of licenses won reflect at least partly differences in applicants' interest in licenses.

In the analysis by auction, the ratio has been relatively constant and close to 1 for non-minorities across all auctions, while for minorities the ratio has varied from 0 to nearly 4. Similarly, while the ratio varies from nearly 0 to almost 2 for women winners, it has been close to 1 for other winners.

When auctions are examined by auction group (Table 22), again minorities and women tend to generate relatively more revenue than their share of the upfront payments in auctions with installment plans. This result again shows that the outcomes for minority and women applicants appear to be influenced by the existence of installment plans.

Table 23 presents the results from the analysis by industry group. Because of lack of data, we were unable to calculate the return-on-payment ratio for two of the five industry groups. In the remaining three groups, the ratios exceed one for minorities in two groups and are well below one in one group, while they are close to one for non-minorities in all groups. The ratios are greater than one for women in all groups, and consistently close to one for other applicants. Again, minority and women winners appear to generally secure licenses with a greater share of the total value of licenses than their share of the upfront payments.

The same pattern is repeated in the analysis of return-on-payment ratios by company size (Table 24): minorities and women have return-on-payment ratios in excess of one, while for other applicants the ratios are close to one.

The analysis of the return-on-payment ratios illustrates that among qualified applicants, minorities and women win licenses of generally the same, or higher, value than other applicants, relative to their upfront payments.

Table 1
General Utilization Ratios of All Applicants by Auction

Auction	Auction Group	Industry Group	APPLIED				WINS				UTILIZATION RATIOS				STATISTICAL SIGNIFICANCE	
			Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority-Owned	Owned	Not Women-Owned	Owned
1			24	6	4	4	0	0	22.22%	0.00%	0.00%	20.00%	+	20.00%	+	+
2			522	164	195	178	63	70	32.12%	38.41%	35.90%	33.03%	84.10%	33.03%	84.10%	49.70%
3			69	35	24	9	2	3	20.59%	5.71%	12.50%	13.33%	+	13.33%	+	+
4			78	8	5	18	0	0	25.71%	0.00%	0.00%	24.66%	+	13.33%	+	+
5			376	89	61	89	25	15	22.30%	28.09%	24.59%	23.49%	73.80%	23.49%	73.80%	14.70%
6			196	21	17	67	5	4	35.43%	23.81%	23.53%	35.20%	66.80%	35.20%	71.10%	66.80%
7			167	7	13	80	4	5	47.50%	57.14%	38.46%	48.70%	38.30%	48.70%	38.30%	52.20%
8			4	1	1	1	0	0	33.33%	0.00%	0.00%	33.33%	+	33.33%	+	+
9			4	1	1	1	0	0	33.33%	0.00%	0.00%	33.33%	+	33.33%	+	+
10			33	5	6	7	2	1	17.86%	40.00%	16.67%	22.22%	+	22.22%	+	89.00%
11			202	27	18	125	16	8	62.29%	59.26%	44.44%	63.59%	23.70%	63.59%	23.70%	+
12			22	1	3	10	0	1	47.62%	0.00%	33.33%	47.37%	+	47.37%	+	+
14			43	2	0	17	1	0	39.02%	50.00%	-	39.53%	+	39.53%	+	+
15			4	0	0	2	0	0	50.00%	-	-	50.00%	+	50.00%	+	+
16			95	5	8	14	2	2	13.33%	40.00%	25.00%	13.79%	+	13.79%	+	60.80%
17			210	13	12	104	4	8	50.76%	30.77%	66.67%	48.48%	83.70%	48.48%	83.70%	+
18			71	5	9	44	1	4	65.15%	20.00%	44.44%	64.52%	+	64.52%	+	+
20			11	1	1	4	0	0	40.00%	0.00%	0.00%	40.00%	+	40.00%	+	+
21			6	2	0	4	0	0	66.67%	-	-	66.67%	+	66.67%	+	95.00%*
Revenue-Weighted Averages**			2,137	391	378	778	125	121	37.40%	31.97%	32.01%	37.35%	95.60%*	37.35%	95.60%*	95.00%*
Total			NA	NA	NA	NA	NA	NA	28.89%	22.02%	18.81%	29.18%		29.18%		

+ Not enough minority or women winners or applicants for valid chi-square test.

* Significant at the 95% level.

** Auctions where women or minorities did not participate are excluded from weight calculations.

✓ See Appendix A for details on chi-square tests.

Auction group 1: With installment plans

Auction group 2: Without installment plans

Industry group 1: Advanced paging/data

Industry group 2: Mobile voice&data

Industry group 3: Interactive data

Industry group 4: Wireless cable

Industry group 5: Multichannel video

Table 2
General Utilization Ratios of All Applicants by Auction Group

Auction Group	APPLIED			WINS			UTILIZATION RATIOS				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	1,565	348	334	555	117	106	35.99%	33.62%	31.74%	36.47%	58.48%	99.90%
2	572	43	44	223	8	15	40.64%	18.60%	34.09%	39.39%	99.56% *	51.16%
Total	2,137	391	378	778	125	121	37.40%	31.97%	32.01%	37.35%	95.63% *	94.97%
Revenue-Weighted Averages**							28.89%	22.02%	18.81%	29.18%		

- Auction group 1 = With installment plans (consists of auctions 2, 3, 5, 6, 7, 10, 11).
- Auction group 2 = No installment plans (consists of auctions 1, 4, 8, 9, 12, 14, 15, 16, 17, 18, 20, 21).
- * Statistically significant at the 95% level.
- ** Auctions where women or minorities did not participate are excluded from weight calculations.
- [^] See Appendix A for details on chi-square tests.

Table 3
General Utilization Ratios of All Applicants by Industry Group

Industry Group	APPLIED			WINS				UTILIZATION RATIOS			STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	164	46	37	57	3	7	45.76%	6.52%	18.92%	39.37%	99.90%*	97.80%*
2	1,037	145	115	370	50	32	35.87%	34.48%	27.83%	36.66%	25.40%	93.80%*
3	406	34	29	171	9	12	43.55%	26.47%	41.38%	42.18%	94.60%	6.70%
4	8	2	2	2	0	0	33.33%	0.00%	0.00%	33.33%	+	+
5	522	164	195	178	63	70	32.12%	38.41%	35.90%	33.03%	84.10%	49.70%
Total	2,137	391	378	778	125	121	37.40%	31.97%	32.01%	37.35%	95.60%*	95.00%*
Revenue-Weighted Averages**							28.89%	22.02%	18.81%	29.18%		

- Industry group 1 = Advanced paging/data (consists of auctions 1, 3, 18).
- Industry group 2 = Mobile voice and data (consists of auctions 4, 5, 7, 10, 11, 12, 14, 15, 16, 20, 21).
- Industry group 3 = Interactive data (consists of auctions 6, 17).
- Industry group 4 = Wireless cable (consists of auctions 8, 9).
- Industry group 5 = Multichannel video (consists of auction 2).

Table 4
General Utilization Ratios of All Applicants by Company Size

Size	APPLIED			WINS			UTILIZATION RATIOS				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
Non-Small	400	32	30	139	6	5	36.14%	18.75%	16.67%	36.22%	95.20%*	96.90%*
Small	1,737	359	348	639	119	116	37.74%	33.15%	33.33%	37.65%	89.20%	86.50%
Total	2,137	391	378	778	125	121	37.40%	31.97%	32.01%	37.35%	95.60%*	95.00%*
Revenue-Weighted Averages**							28.89%	22.02%	18.81%	29.18%		

- + Not enough minority or women winners or applicants for valid chi-square test.
- * Significant at the 95% level.
- ** Auctions where women or minorities did not participate are excluded from weight calculations.
- [^] See Appendix A for details on chi-square tests.

Table 5
Qualifying Ratios By Auction

GROUPS		APPLICANTS			QUALIFIED		QUALIFYING RATIOS					STATISTICAL SIGNIFICANCE	
Auction	Auction Group	Industry Group	Total	Minority-Owned	Women-Owned	Total	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority-Owned	Not Women-Owned	Owned
1	2	1	24	6	4	23	4	94.44%	100.00%	100.00%	95.00%	44.50%	35.20%
2	1	1	522	164	195	241	91	46.93%	44.51%	46.67%	45.87%	39.30%	14.00%
3	1	1	69	35	24	28	8	52.94%	28.57%	33.33%	44.44%	96.10%*	62.90%
4	2	2	78	8	5	30	0	42.86%	0.00%	0.00%	41.10%	+	+
5	1	1	376	89	61	255	46	72.82%	51.69%	55.74%	70.16%	99.90%*	97.30%*
6	1	1	196	21	17	155	13	81.14%	61.90%	70.59%	79.89%	95.90%*	63.20%
7	1	1	167	7	13	128	5	76.88%	71.43%	76.92%	76.62%	26.10%	2.00%
8	2	2	4	1	1	3	0	100.00%	0.00%	0.00%	100.00%	+	+
9	4	4	4	1	1	2	0	66.67%	0.00%	0.00%	66.67%	+	+
10	1	1	33	5	6	32	4	100.00%	80.00%	83.33%	100.00%	98.40%*	96.90%*
11	1	1	202	27	18	153	16	78.29%	59.26%	44.44%	78.80%	96.80%*	99.90%*
12	2	2	22	1	3	22	1	100.00%	100.00%	100.00%	100.00%	+	+
14	2	2	43	2	0	24	1	56.10%	50.00%	-	55.81%	+	+
15	2	2	4	0	0	4	0	100.00%	-	-	100.00%	+	+
16	2	2	95	5	8	62	5	64.44%	80.00%	62.50%	65.52%	52.30%	13.60%
17	3	2	210	13	12	139	8	67.51%	46.15%	66.67%	66.16%	88.50%	2.90%
18	1	2	71	5	9	54	3	77.27%	60.00%	77.78%	75.81%	61.70%	10.30%
20	2	2	11	1	1	8	1	70.00%	100.00%	100.00%	70.00%	+	+
21	2	2	6	0	0	5	0	83.33%	83.33%	-	83.33%	+	+

Revenue Weighted Averages**

+ Not enough minority or women winners or applicants for valid chi-square test.

* Statistically significant at the 95% level.

** Auctions where women or minorities did not participate are excluded from weight calculations.

^ See Appendix A for details on chi-square tests.

Auction group 1: With installment plans

Auction group 2: Without installment plans

Industry group 1: Advanced paging/data

Industry group 2: Mobile voice&data

Industry group 3: Interactive data

Industry group 4: Wireless cable

Industry group 5: Multichannel video

Table 6
Qualifying Ratios by Auction Group

Auction Group	APPLICANTS			QUALIFIED			QUALIFYING RATIOS				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	1,565	348	334	992	167	168	67.79%	47.99%	50.30%	66.94%	99.99% *	99.90% *
2	572	43	44	376	22	28	66.92%	51.16%	63.64%	65.91%	96.37% *	23.97%
Total	2,137	391	378	1,368	189	196	67.53%	48.34%	51.85%	66.63%	99.99% *	99.99% *
Revenue Weighted Averages**							66.14%	37.43%	38.38%	64.35%		

- Auction group 1 = With installment plans (consists of auctions 2, 3, 5, 6, 7, 10, 11).

- Auction group 2 = No installment plans (consists of auctions 1, 4, 8, 9, 12, 14, 15, 16, 17, 18, 20, 21).

* Statistically significant at the 95% level.

** Auctions where women or minorities did not participate are excluded from weight calculations.

[^] See Appendix A for details on chi-square tests.

Table 7
Qualifying Ratios by Industry Group

Industry Group	APPLICANTS			QUALIFIED			QUALIFYING RATIOS				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	164	46	37	105	19	19	72.88%	41.30%	51.35%	67.72%	99.90%*	93.20%
2	1,037	145	115	723	78	66	72.31%	53.79%	57.39%	71.26%	99.90%*	99.80%*
3	406	34	29	294	19	20	73.92%	55.88%	68.97%	72.68%	97.60%*	33.40%
4	8	2	2	5	0	0	83.33%	0.00%	0.00%	83.33%	+	+
5	522	164	195	241	73	91	46.93%	44.51%	46.67%	45.87%	39.30%	14.00%
Total	2,137	391	378	1,368	189	196	67.53%	48.34%	51.85%	66.63%	99.90%*	99.90%*
Revenue Weighted Averages**							66.14%	37.43%	38.38%	64.35%		

- Industry group 1 = Advanced paging/data (consists of auctions 1, 3, 18).
- Industry group 2 = Mobile voice and data (consists of auctions 4, 5, 7, 10, 11, 12, 14, 15, 16, 20, 21).
- Industry group 3 = Interactive data (consists of auctions 6, 17).
- Industry group 4 = Wireless cable (consists of auctions 8, 9).
- Industry group 5 = Multichannel video (consists of auction 2).

Table 8
Qualifying Ratios by Company Size

Size	APPLICANTS			QUALIFIED			QUALIFYING RATIOS				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
Non-Small	400	32	30	244	13	11	62.77%	40.63%	36.67%	62.97%	98.60%*	99.60%*
Small	1,737	359	348	1,124	176	185	68.80%	49.03%	53.16%	67.60%	99.90%*	99.90%*
Total	2,137	391	378	1,368	189	196	67.53%	48.34%	51.85%	66.63%	99.90%*	99.90%*
Revenue Weighted Averages**							66.14%	37.43%	38.38%	64.35%		

- + Not enough minority or women winners or applicants for valid chi-square test.
- * Statistically significant at the 95% level.
- [^] See Appendix A for details on chi-square tests.
- ** Auctions where women or minorities did not participate are excluded from weight calculations.

Table 9
Success Ratios of Qualified Applicants by Auction

GROUPS			QUALIFIED			WINS			SUCCESS RATIOS				STATISTICAL SIGNIFICANCE^	
									Non			Not	Non	
Auction	Auction Group	Industry Group	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Minority-Owned	Minority-Owned	Women-Owned	Women-Owned	Minority-Owned	Not Women/Women-Owned
1	2	1	23	6	4	4	0	0	23.53%	0.00%	0.00%	21.05%	+	+
2	1	5	241	73	91	178	63	70	68.45%	86.30%	76.92%	72.00%	99.60%*	80.90%
3	1	1	28	10	8	9	2	3	38.89%	20.00%	37.50%	30.00%	+	+
4	2	2	30	0	0	18	0	0	60.00%	-	-	60.00%	+	+
5	1	2	255	46	34	89	25	15	30.62%	54.35%	44.12%	33.48%	99.80%*	77.40%
6	1	3	155	13	12	67	5	4	43.66%	38.46%	33.33%	44.06%	28.30%	52.90%
7	1	2	128	5	10	80	4	5	61.79%	80.00%	50.00%	63.56%	59.00%	60.50%
8	2	4	3	0	0	1	0	0	33.33%	-	-	33.33%	+	+
9	2	4	2	0	0	1	0	0	50.00%	-	-	50.00%	+	+
10	1	2	32	4	5	7	2	1	17.86%	50.00%	20.00%	22.22%	+	+
11	1	2	153	16	8	125	16	8	79.56%	100.00%	100.00%	80.69%	95.50%*	83.10%
12	2	2	22	1	3	10	0	1	47.62%	0.00%	33.33%	47.37%	+	+
14	2	2	24	1	0	17	1	0	69.57%	100.00%	-	70.83%	+	+
15	2	2	4	0	0	2	0	0	50.00%	-	-	50.00%	+	+
16	2	2	62	4	5	14	2	2	20.69%	50.00%	40.00%	21.05%	82.50%	90.90%
17	2	3	139	6	8	104	4	8	75.19%	66.67%	100.00%	73.28%	+	+
18	2	1	54	3	7	44	1	4	84.31%	33.33%	57.14%	85.11%	+	+
20	2	2	8	1	1	4	0	0	57.14%	0.00%	0.00%	57.14%	+	+
21	2	2	5	0	0	4	0	0	80.00%	-	-	80.00%	+	+
Total	NA	NA	1,368	189	196	778	125	121	55.39%	66.14%	61.73%	56.06%	99.40%*	86.30%
Revenue-Weighted Averages**									40.44%	59.65%	52.43%	42.41%		

+ Not enough minority or women winners or applicants for valid chi-square test.

* Statistically significant at the 95% level.

** Auctions where women or minorities did not participate are excluded from weight calculations.

^ See Appendix A for details on chi-square tests.

Auction group 1: With installment plans Auction group 2: Without installment plans

Industry group 1: Advanced paging/data Industry group 2: Mobile voice&data Industry group 3: Interactive data Industry group 4: Wireless cable

Industry group 5: Multichannel video

Table 10
Success Ratios of Qualified Applicants by Auction Group

Auction Group	QUALIFIED			WINS			SUCCESS RATIOS				STATISTICAL SIGNIFICANCE^	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	992	167	168	555	117	106	53.09%	70.06%	63.10%	54.49%	99.99% *	95.94% *
2	376	22	28	223	8	15	60.73%	36.36%	53.57%	59.77%	97.60% *	47.93%
Total	1,368	189	196	778	125	121	55.39%	66.14%	61.73%	56.06%	99.44% *	86.25%
Revenue-Weighted Averages**							40.44%	59.65%	52.43%	42.41%		

- Auction group 1 = With installment plans (consists of auctions 2, 3, 5, 6, 7, 10, 11).

- Auction group 2 = No installment plans (consists of auctions 1, 4, 8, 9, 12, 14, 15, 16, 17, 18, 20, 21).

* Statistically significant at the 95% level.

** Auctions where women or minorities did not participate are excluded from weight calculations.

^ See Appendix A for details on chi-square tests.

Table 11
Success Ratios of Qualified Applicants by Industry Group

Industry Group	QUALIFIED			WINS			SUCCESS RATIOS				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	105	19	19	57	3	7	62.79%	15.79%	36.84%	58.14%	99.90%*	93.20%
2	723	78	66	370	50	32	49.61%	64.10%	48.48%	51.45%	99.80%*	99.80%*
3	294	19	20	171	9	12	58.91%	47.37%	60.00%	58.03%	97.60%*	33.40%
4	5	0	0	2	0	0	40.00%	-	-	40.00%	+	+
5	241	73	91	178	63	70	68.45%	86.30%	76.92%	72.00%	99.60%*	80.90%
Total	1,368	189	196	778	125	121	55.39%	66.14%	61.73%	56.06%	99.40%*	86.30%
Revenue-Weighted Averages**							40.44%	59.65%	52.43%	42.41%		

- Industry group 1 = Advanced paging/data (consists of auctions 1, 3, 18).
- Industry group 2 = Mobile voice and data (consists of auctions 4, 5, 7, 10, 11, 12, 14, 15, 16, 20, 21).
- Industry group 3 = Interactive data (consists of auctions 6, 17).
- Industry group 4 = Wireless cable (consists of auctions 8, 9).
- Industry group 5 = Multichannel video (consists of auction 2).

Table 12
Success Ratios of Qualified Applicants by Company Size

Size	QUALIFIED			WINS			SUCCESS RATIOS				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
Non-Small	244	13	11	139	6	5	57.58%	46.15%	45.45%	57.51%	58.20%	57.00%
Small	1,124	176	185	639	119	116	54.85%	67.61%	62.70%	55.70%	99.80%*	92.10%
Total	1,368	189	196	778	125	121	55.39%	66.14%	61.73%	56.06%	99.40%*	86.30%
Revenue-Weighted Averages**							40.44%	59.65%	52.43%	42.41%		

* Statistically significant at the 95% level.

** Auctions where women or minorities did not participate are excluded from weight calculations.

[^] See Appendix A for details on chi-square tests.

Table 13
Economic Value Ratio by Auction

GROUPS			NET REVENUE (\$)			NET REVENUE SHARE RATIO			
Auction	Auction Group	Industry Group	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
1	2	1	522,500,000	0	0	100.00%	0.00%	0.00%	100.00%
2	1	5	213,892,375	67,639,625	96,713,125	68.38%	31.62%	45.22%	54.78%
3	1	1	392,706,797	98,926,414	144,099,005	74.81%	25.19%	36.69%	63.31%
4	2	2	7,019,403,797	0	0	100.00%	0.00%	0.00%	100.00%
5	1	2	10,071,708,842	2,329,565,519	1,539,695,042	76.87%	23.13%	15.29%	84.71%
6	1	3	216,239,603	3,329,617	4,733,800	98.46%	1.54%	2.19%	97.81%
7	1	2	204,267,144	10,636,800	11,337,576	94.79%	5.21%	5.55%	94.45%
8	2	4	682,500,000	0	0	100.00%	0.00%	0.00%	100.00%
9	2	4	52,295,000	0	0	100.00%	0.00%	0.00%	100.00%
10	1	2	904,607,467	223,010,250	23,619,778	75.35%	24.65%	2.61%	97.39%
11	1	2	2,517,439,565	79,809,552	23,051,314	96.83%	3.17%	0.92%	99.08%
12	2	2	1,842,533	0	7,100	100.00%	0.00%	0.39%	99.61%
14	2	2	13,638,940	31,735	-	99.77%	0.23%	-	100.00%
15	2	2	173,234,888	-	-	100.00%	-	-	100.00%
16	2	2	96,232,060	521,885	521,885	99.46%	0.54%	0.54%	99.46%
17	2	3	578,663,029	417,475	16,912,510	99.93%	0.07%	2.92%	97.08%
18	2	1	21,650,301	390,608	417,323	98.20%	1.80%	1.93%	98.07%
20	2	2	7,459,200	0	0	100.00%	0.00%	0.00%	100.00%
21	2	2	3,438,294	-	-	100.00%	-	-	100.00%
Total	NA	NA	23,693,719,833	2,814,279,480	1,861,108,457	88.12%	11.88%	7.85%	92.15%

Auction group 1: With installment plans
Industry group 1: Advanced paging/data
Industry group 5: Multichannel video

Auction group 2: Without installment plans
Industry group 2: Mobile voice&data

Industry group 3: Interactive data Industry group 4: Wireless cable

Table 14
Economic Value Ratio by Auction Group

Auction Group	NET REVENUE (\$)			NET REVENUE SHARE RATIO			
	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
1	14,520,861,792	2,812,917,777	1,843,249,639	80.63%	19.37%	12.69%	87.31%
2	9,172,858,042	1,361,703	17,858,818	99.99%	0.01%	0.19%	99.81%
Total	23,693,719,834	2,814,279,480	1,861,108,457	88.12%	11.88%	7.85%	92.15%

- Auction group 1 = With installment plans (consists of auctions 2, 3, 5, 6, 7, 10, 11).
- Auction group 2 = No installment plans (consists of auctions 1, 4, 8, 9, 12, 14, 15, 16, 17, 18, 20, 21).

Table 15
Economic Value Ratio by Industry Group

Industry Group	NET REVENUE (\$)			NET REVENUE SHARE RATIO			
	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
1	936,857,098	99,317,022	144,516,328	89.40%	10.60%	15.43%	84.57%
2	21,013,272,729	2,643,575,741	1,598,232,694	87.42%	12.58%	7.61%	92.39%
3	794,902,632	3,747,092	21,646,310	99.53%	0.47%	2.72%	97.28%
4	734,795,000	0	0	100.00%	-	-	100.00%
5	213,892,375	67,639,625	96,713,125	68.38%	31.62%	45.22%	54.78%
Total	23,693,719,833	2,814,279,480	1,861,108,457	88.12%	11.88%	7.85%	92.15%

- Industry group 1 = Advanced paging/data (consists of auctions 1, 3, 18).
- Industry group 2 = Mobile voice and data (consists of auctions 4, 5, 7, 10, 11, 12, 14, 15, 16, 20, 21).
- Industry group 3 = Interactive data (consists of auctions 6, 17).
- Industry group 4 = Wireless cable (consists of auctions 8, 9).
- Industry group 5 = Multichannel video (consists of auction 2).

Table 16
Economic Value Ratio by Company Size

Size	NET REVENUE (\$)			NET REVENUE SHARE RATIO			
	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
Not Small	10,979,543,634	8,383,842	5,631,850	99.92%	0.08%	0.05%	99.95%
Small	12,714,176,199	2,805,895,638	1,855,476,607	77.93%	22.07%	14.59%	85.41%
Total	23,693,719,833	2,814,279,480	1,861,108,457	88.12%	11.88%	7.85%	92.15%

Table 17
Average Economic Value per Winner by Auction

GROUPS			WINS			NET REVENUE (\$)			AVERAGE NET REVENUE PER WINNER (\$)				STATISTICAL SIGNIFICANCE*	
Auction	Auction Group	Industry Group	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	2	1	4	0	0	522,500,000	0	0	130,625,000	-	-	130,625,000	+	+
2	1	5	178	63	70	213,892,375	67,639,625	96,713,125	1,271,763	1,073,645	1,381,616	1,084,993	71.10%	71.61%
3	1	1	9	2	3	392,706,797	98,926,414	144,099,005	41,968,626	49,463,207	48,033,002	41,434,632	55.52%	59.64%
4	2	2	18	0	0	7,019,403,797	-	-	389,966,878	-	-	389,966,878	+	+
5	1	2	89	25	15	10,071,708,842	2,329,565,519	1,539,695,042	120,970,989	93,182,621	102,646,336	115,297,484	62.15%	54.46%
6	1	3	67	5	4	216,239,603	3,329,617	4,733,800	3,434,032	665,923	1,183,450	3,357,235	99.64%*	96.56%*
7	1	2	80	4	5	204,267,144	10,636,800	11,337,576	2,547,768	2,659,200	2,267,515	2,572,394	51.67%	99.84%
8	2	4	1	0	0	682,500,000	-	-	682,500,000	-	-	682,500,000	+	+
9	2	4	1	0	0	52,295,000	-	-	52,295,000	-	-	52,295,000	+	+
10	1	2	7	2	1	904,607,467	223,010,250	23,619,778	136,319,443	111,505,125	23,619,778	146,831,282	56.23%	+
11	1	2	125	16	8	2,517,439,565	79,809,552	23,051,314	22,363,578	4,988,097	2,881,414	21,319,558	98.68%*	99.63%*
12	2	2	10	0	1	1,842,533	0	7,100	184,253	-	7,100	203,937	+	+
14	2	2	17	1	0	13,638,940	31,735	-	850,450	31,735	-	802,291	+	+
15	2	2	2	0	0	173,234,888	-	-	86,617,444	-	-	86,617,444	+	+
16	2	2	14	2	2	96,232,060	521,885	521,885	7,975,848	260,943	260,943	7,975,848	80.98%	84.17%
17	2	3	104	4	8	578,663,029	417,475	16,912,510	5,782,456	104,369	2,114,064	5,851,568	93.26%	88.51%
18	2	1	44	1	4	21,650,301	390,608	417,323	494,411	390,608	104,331	530,824	+	90.22%
20	2	2	4	0	0	7,459,200	0	0	1,864,800	-	-	1,864,800	+	+
21	2	2	4	0	0	3,438,294	-	-	859,574	-	-	859,574	+	+
Total	NA	NA	778	125	121	23,693,719,833	2,814,279,480	1,861,108,457	31,974,641	22,514,236	15,381,062	33,230,763	74.15%	89.08%

* Statistically significant at 95% level.

+ Not enough minority or women winners or applicants for valid t-test.

^ See Appendix B for details on t-tests.

Auction group 1: With installment plans

Auction group 2: Without installment plans

Industry group 1: Advanced paging/data

Industry group 2: Mobile voice&data

Industry group 3: Interactive data

Industry group 4: Wireless cable

Industry group 5: Multichannel video

Table 18
Average Economic Value per Winner by Auction Group

Auction Group	WINS			NET REVENUE (\$)			AVERAGE NET REVENUE PER WINNER (\$)				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	555	117	106	14,520,861,792	2,812,917,777	1,843,249,639	26,730,466	24,042,032	17,389,148	28,235,216	56.51%	73.98%
2	223	8	15	9,172,858,042	1,361,703	17,858,818	42,658,123	170,213	1,190,588	44,014,419	99.82% *	99.77% *
Total	778	125	121	23,693,719,834	2,814,279,480	1,861,108,457	31,974,641	22,514,236	15,381,062	33,230,763	74.15%	89.08%

- Auction group 1 = With installment plans (consists of auctions 2, 3, 5, 6, 7, 10, 11).

- Auction group 2 = No installment plans (consists of auctions 1, 4, 8, 9, 12, 14, 15, 16, 17, 18, 20, 21).

* Statistically significant at the 95% level.

[^] See Appendix B for details on t-tests.

Table 19
Average Economic Value per Winner by Industry Group

Industry Group	WINS			NET REVENUE (\$)			AVERAGE NET REVENUE PER WINNER (\$)				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
1	57	3	7	936,857,098	99,317,022	144,516,328	15,510,001	33,105,674	20,645,190	15,846,815	69.42%	63.03%
2	370	50	32	21,013,272,729	2,643,575,741	1,598,232,694	57,405,303	52,871,515	49,944,772	57,440,947	55.30%	56.27%
3	171	9	12	794,902,632	3,747,092	21,646,310	4,883,676	416,344	1,803,859	4,863,247	99.83%*	93.83%
4	2	0	0	734,795,000	-	-	367,397,500	-	-	367,397,500	+	+
5	178	63	70	213,892,375	67,639,625	96,713,125	1,271,763	1,073,645	1,381,616	1,084,993	71.10%	71.61%
Total	778	125	121	23,693,719,833	2,814,279,480	1,861,108,457	31,974,641	22,514,236	15,381,062	33,230,763	74.15%	89.08%

- Industry group 1 = Advanced paging/data (consists of auctions 1, 3, 18).
- Industry group 2 = Mobile voice and data (consists of auctions 4, 5, 7, 10, 11, 12, 14, 15, 16, 20, 21).
- Industry group 3 = Interactive data (consists of auctions 6, 17).
- Industry group 4 = Wireless cable (consists of auctions 8, 9).
- Industry group 5 = Multichannel video (consists of auction 2).

Table 20
Average Economic Value per Winner by Company Size

Size	WINS			NET REVENUE (\$)			AVERAGE NET REVENUE PER WINNER (\$)				STATISTICAL SIGNIFICANCE [^]	
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned	Non Minority/Minority-Owned	Not Women/Women-Owned
Non-Small	139	6	5	10,979,543,634	8,383,842	5,631,850	82,489,923	1,397,307	1,126,370	81,894,864	99.97%*	99.97%*
Small	639	119	116	12,714,176,199	2,805,895,638	1,855,476,607	19,054,386	23,578,955	15,995,488	20,762,332	65.41%	62.44%
Total	778	125	121	23,693,719,833	2,814,279,480	1,861,108,457	31,974,641	22,514,236	15,381,062	33,230,763	74.15%	89.08%

*Statistically significant at the 95% level.

+ Not enough minority or women winners or applicants for valid t-test.

[^] See Appendix B for details on t-tests.

Table 21
Return on Payment Ratios for Qualified Applicants by Auction

GROUPS			Upfront Payments (\$)			Net Revenue (\$)			Return On Payment			
Auction	Auction Group	Industry Group	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
1	2	1	No data	No data	No data	Not included	Not included	Not included	No data	No data	No data	No data
2	1	5	No data	No data	No data	213,892,375	67,639,625	96,713,125	No data	No data	No data	-
3	1	1	No data	No data	No data	Not included	Not included	Not included	No data	No data	No data	No data
4	2	2	522,339,935	0	0	7,019,403,797	0	0	1.00	-	-	1.00
5	1	2	767,591,100	157,243,732	66,206,561	10,071,708,842	2,329,565,519	1,539,695,042	0.97	1.13	1.77	0.93
6	1	3	15,028,291	270,311	366,383	216,239,603	3,329,617	4,733,800	1.00	0.86	0.90	1.00
7	1	2	41,144,002	660,077	1,168,397	204,267,144	10,636,800	11,337,576	0.96	3.25	1.95	0.97
8	2	4	No data	No data	No data	Not included	Not included	Not included	No data	No data	No data	No data
9	2	4	No data	No data	No data	Not included	Not included	Not included	No data	No data	No data	No data
10	1	2	49,716,127	7,365,238	4,100,238	904,607,467	223,010,250	23,619,778	0.88	1.66	0.32	1.06
11	1	2	763,199,365	13,996,809	10,122,758	2,517,439,565	79,809,552	23,051,314	0.99	1.73	0.69	1.00
12	2	2	170,000	5,000	15,000	1,842,533	0	7,100	1.03	0.00	0.04	1.09
14	2	2	232,789,217	137,850	-	13,638,940	31,735	-	1.00	3.93	-	1.00
15	2	2	No data	No data	No data	Not included	Not included	Not included	No data	No data	No data	No data
16	2	2	18,358,604	146,851	94,347	96,232,060	521,885	521,885	1.00	0.68	1.06	1.00
17	2	3	359,693,769	6,044,815	7,455,432	578,663,029	417,475	16,912,510	1.02	0.04	1.41	0.99
18	2	1	14,947,467	212,455	246,611	21,650,301	390,608	417,323	1.00	1.27	1.17	1.00
20	2	2	No data	No data	No data	Not included	Not included	Not included	No data	No data	No data	No data
21	2	2	No data	No data	No data	Not included	Not included	Not included	No data	No data	No data	No data
Total	NA	NA	2,784,977,878	186,083,138	89,775,727	21,859,585,655	2,715,353,066	1,717,009,453	0.94	1.86	2.44	0.95

No data indicates that no data were available for these categories.

Not included indicates that data exist for these categories but have been omitted so that totals are calculated for auctions with valid upfront payment data only.

Auction group 1: With installment plans

Auction group 2: Without installment plans

Industry group 1: Advanced paging/data

Industry group 2: Mobile voice&data

Industry group 3: Interactive data

Industry group 4: Wireless cable

Industry group 5: Multichannel video

Table 22
Return on Payment Ratios for Qualified Applicants by Auction Group

Auction Group	Upfront Payments (\$)			Net Revenue (\$)			Return On Payment			
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
1	1,636,678,886	179,536,167	81,964,337	14,128,154,995	2,713,991,363	1,699,150,635	0.91	1.75	2.40	0.93
2	1,148,298,992	6,546,971	7,811,390	7,731,430,660	1,361,703	17,858,818	1.01	0.03	0.34	1.00
Total	2,784,977,878	186,083,138	89,775,727	21,859,585,655	2,715,353,066	1,717,009,453	0.94	1.86	2.44	0.95

- Auction group 1 = With installment plans (consists of auctions 2, 3, 5, 6, 7, 10, 11).
- Auction group 2 = No installment plans (consists of auctions 1, 4, 8, 9, 12, 14, 15, 16, 17, 18, 20, 21).

Table 23
Return on Payment Ratios for Qualified Applicants by Industry Group

Industry Group	Upfront Payments (\$)			Net Revenue (\$)			Return On Payment			
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
1	14,947,467	212,455	246,611	21,650,301	390,608	417,323	1.00	1.27	1.17	1.00
2	2,395,308,351	179,555,557	81,707,301	20,829,140,347	2,643,575,741	1,598,232,694	0.94	1.69	2.25	0.96
3	374,722,060	6,315,126	7,821,815	794,902,632	3,747,092	21,646,310	1.01	0.28	1.30	0.99
4	No data	No data	No data	Not Included	Not Included	Not Included	No data	No data	No data	No data
5	No data	No data	No data	213,892,375	67,639,625	96,713,125	No data	No data	No data	No data
Total	2,784,977,878	186,083,138	89,775,727	21,859,585,655	2,715,353,066	1,717,009,453	0.94	1.86	2.44	0.95

- Industry group 1 = Advanced paging/data (consists of auctions 1, 3, 18).
- Industry group 2 = Mobile voice and data (consists of auctions 4, 5, 7, 10, 11, 12, 14, 15, 16, 20, 21).
- Industry group 3 = Interactive data (consists of auctions 6, 17).
- Industry group 4 = Wireless cable (consists of auctions 8, 9).
- Industry group 5 = Multichannel video (consists of auction 2).

Table 24
Return on Payment Ratios for Qualified Applicants by Company Size

Size	Upfront Payments (\$)			Net Revenue (\$)			Return On Payment			
	Total	Minority-Owned	Women-Owned	Total	Minority-Owned	Women-Owned	Non Minority-Owned	Minority-Owned	Women-Owned	Not Women-Owned
Non-Small	1,407,585,613	189,800	310,000	9,355,223,633	8,383,842	5,631,850	1.00	6.65	2.73	1.00
Small	1,377,392,265	185,893,338	89,465,727	12,504,362,022	2,706,969,224	1,711,377,603	0.91	1.60	2.11	0.92
Total	2,784,977,878	186,083,138	89,775,727	21,859,585,655	2,715,353,066	1,717,009,453	0.94	1.86	2.44	0.95

No data indicates that no data were available for these categories.

Not included indicates that data exist for these categories but have been omitted so that totals are calculated for auctions with valid upfront payment data only.

Appendix A: Chi-Square Test of Statistical Significance

A chi-square test is used to determine whether there are systematic differences in utilization ratios across demographic groups for each auction. The null hypothesis of the chi-square test is that there are no such differences in ratios.

The chi-square test statistic is based on a frequency table. In the case of utilization ratios, the frequency tables are 2x2 tables with demographic group (e.g. minority/non-minority) along one dimension and auction outcome (e.g., winner/non-winner) along the other. The chi square test statistic is calculated as:

$$\chi^2_{df} = \sum_{i=1}^R \sum_{j=1}^C \frac{(f_{ij} - e_{ij})^2}{e_{ij}}$$

where f_{ij} is the observed frequency in the ij cell of the frequency table
 e_{ij} is the expected frequency in the ij cell if the null hypothesis is true
 R is the number of rows in the frequency table
 C is the number of columns in the frequency table

The expected frequency under the null hypothesis is calculated as:

$$e_{ij} = \frac{(f_i)(f_j)}{N}$$

where f_i is the total in the i th row marginal
 f_j is the total in the j th row marginal
 N is the total number of observations in the frequency table

The degrees of freedom for this test statistic are given by:

$$df = (R-1)(C-1)$$

Reference:

Knoke, David, and George W. Bohrnstedt, *Statistics for Social Data Analysis*, F.E. Peacock Publishers Inc., Itasca IL., 1994.

Appendix B: t test: Testing for the Difference Between Two Means

A t-test is used to determine whether two means are equal. The null hypothesis under the t-test is that there are no differences in the means. To determine if the difference of the average net revenues between the minority and non-minority license winners and the male and female winners were significantly different, we used the following form of the t-test:

$$t_{df} = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where \bar{x} is the mean of the first group

\bar{y} is the mean of the second group

S_1^2 is the variance from the first group

S_2^2 is the variance of the second group

n_1 is the total number of observations in the first group

n_2 is the total number of observations in the second group

The degrees of freedom can be approximated as follows:

$$df = \frac{(S_1^2 + S_2^2)^2}{\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{S_2^2}{n_2}\right)^2}{n_2 - 1}}$$

The null hypothesis that the mean difference is zero is rejected if the test statistic t is greater than the critical value at a .05 level of significance. In other words, if the calculated t is greater than the critical value, we would conclude that there is a statistically significant difference between the two means.

Reference:

Dixon, Wilfrid J., and Frank J. Massey Jr., *Introduction to Statistical Analysis*, McGraw-Hill Company, New York, 1969.